US011391163B1

(12) **United States Patent**
Liles et al.

(10) **Patent No.: US 11,391,163 B1**
(45) **Date of Patent: Jul. 19, 2022**

(54) **VANE ARC SEGMENT WITH SEAL**

(71) Applicant: **RAYTHEON TECHNOLOGIES CORPORATION**, Farmington, CT (US)

(72) Inventors: **Howard J. Liles**, Newington, CT (US); **Robert A. White, III**, Meriden, CT (US); **Jon E. Sobanski**, Glastonbury, CT (US)

(73) Assignee: **RAYTHEON TECHNOLOGIES CORPORATION**, Farmington, CT (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/193,343**

(22) Filed: **Mar. 5, 2021**

(51) **Int. Cl.**
F01D 5/18 (2006.01)
F01D 9/04 (2006.01)

(52) **U.S. Cl.**
CPC ***F01D 5/187*** (2013.01); *F01D 5/188* (2013.01); *F01D 9/041* (2013.01); *F05D 2240/126* (2013.01); *F05D 2260/201* (2013.01)

(58) **Field of Classification Search**
CPC F01D 5/187; F01D 5/188; F01D 9/041; F05D 2260/201; F05D 2240/126
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,464,456 B2 * 10/2002 Darolia F01D 5/3084 415/209.2
7,452,189 B2 * 11/2008 Shi .... F01D 5/147 416/241 B
9,556,750 B2 1/2017 Freeman et al.
10,094,239 B2 10/2018 Freeman et al.
11,008,888 B2 * 5/2021 Sippel F01D 9/042
2002/0127097 A1 * 9/2002 Darolia F01D 5/3084 415/137
2016/0376899 A1 12/2016 Prugarewicz et al.
2020/0025025 A1 * 1/2020 Sippel F01D 9/065

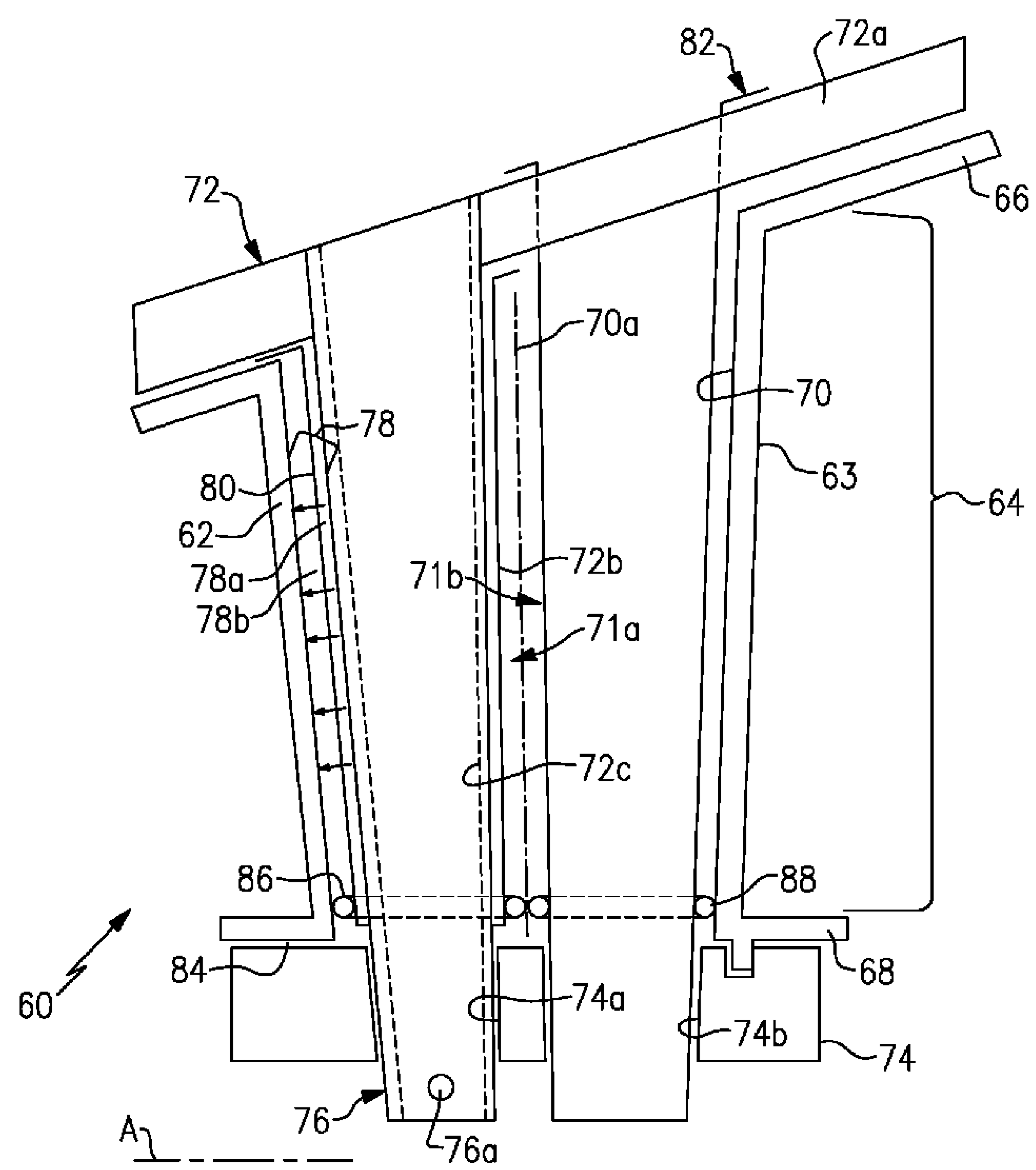
* cited by examiner

Primary Examiner — Eldon T Brockman
(74) *Attorney, Agent, or Firm* — Carlson, Gaskey & Olds, P.C.

(57) **ABSTRACT**

A vane arc segment includes an airfoil wall that defines first and second fairing platforms and a hollow airfoil section. A spar leg extends through the hollow airfoil section and has an end portion that protrudes from the hollow airfoil section. The spar leg is spaced from the airfoil wall in the hollow airfoil section such that there is a first gap. There is a support platform adjacent the second airfoil fairing and a second gap therebetween. A baffle is disposed in the first gap and is spaced apart from the airfoil wall and the spar leg so as to divide the first gap into a plenum space between the spar leg and the baffle and an impingement space between the baffle and the airfoil wall. A seal is disposed between the airfoil wall and the spar leg to seal the impingement space from the second gap.

20 Claims, 5 Drawing Sheets



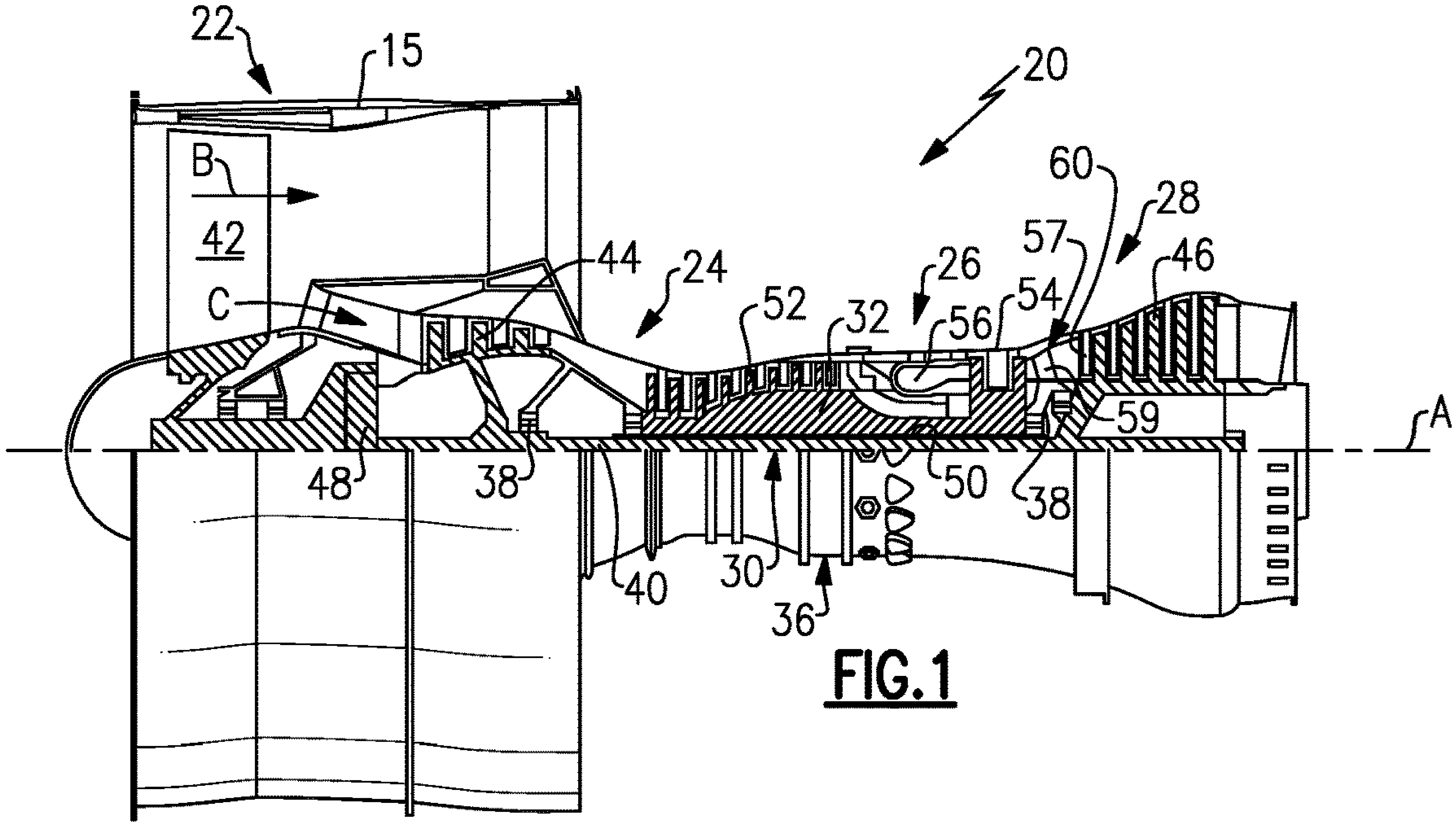

22
15
20
B
42
C
44
24
52
32
26
56
54
60
57
28
46
48
38
50
59
A
38
40
30
36

FIG.1

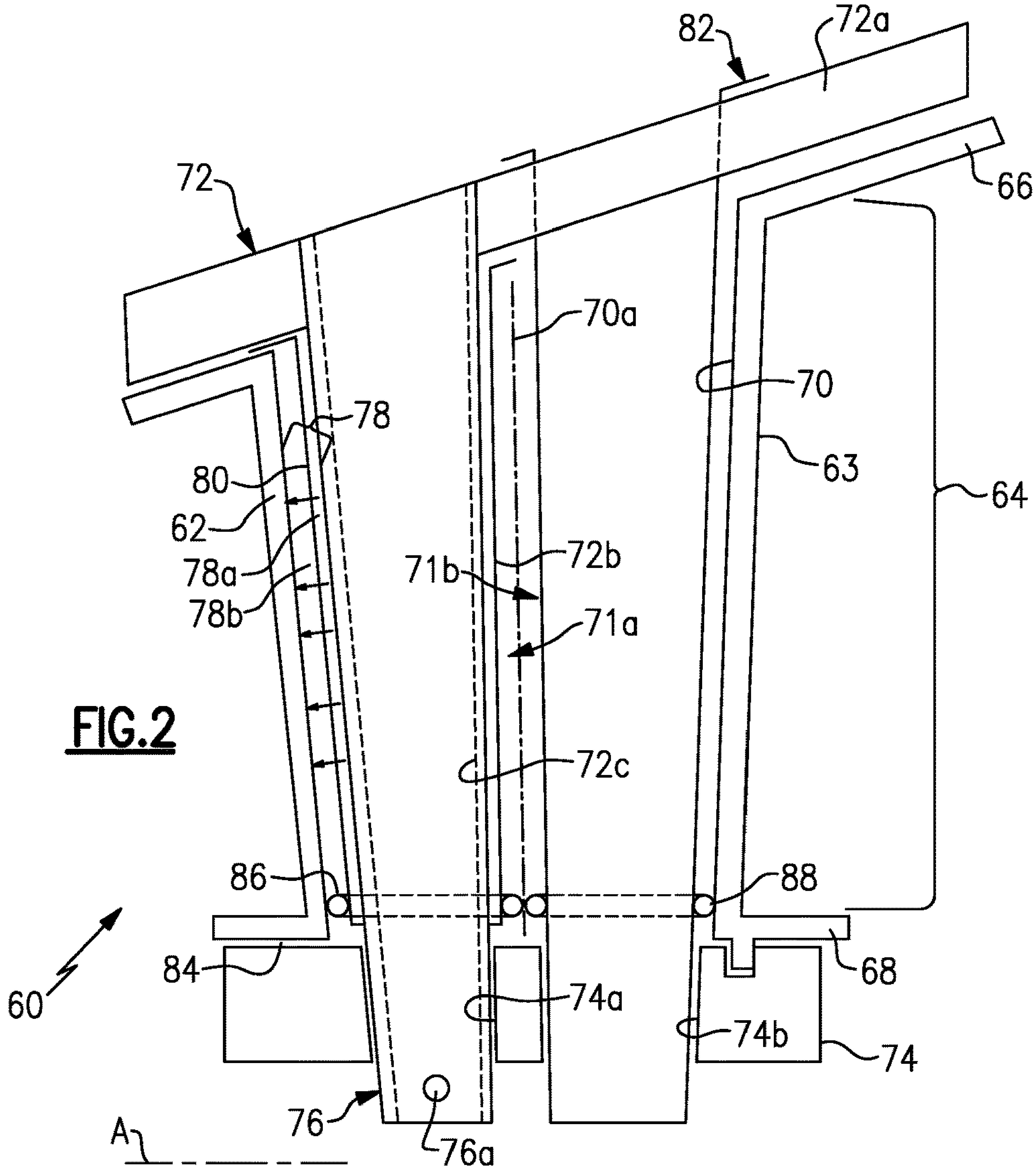

82
72a
72
66
70a
70
78
80
63
64
62
78a
78b
71b
72b
71a
72c
86
88
84
68
74a
60
74b
74
76
76a
A

FIG.2

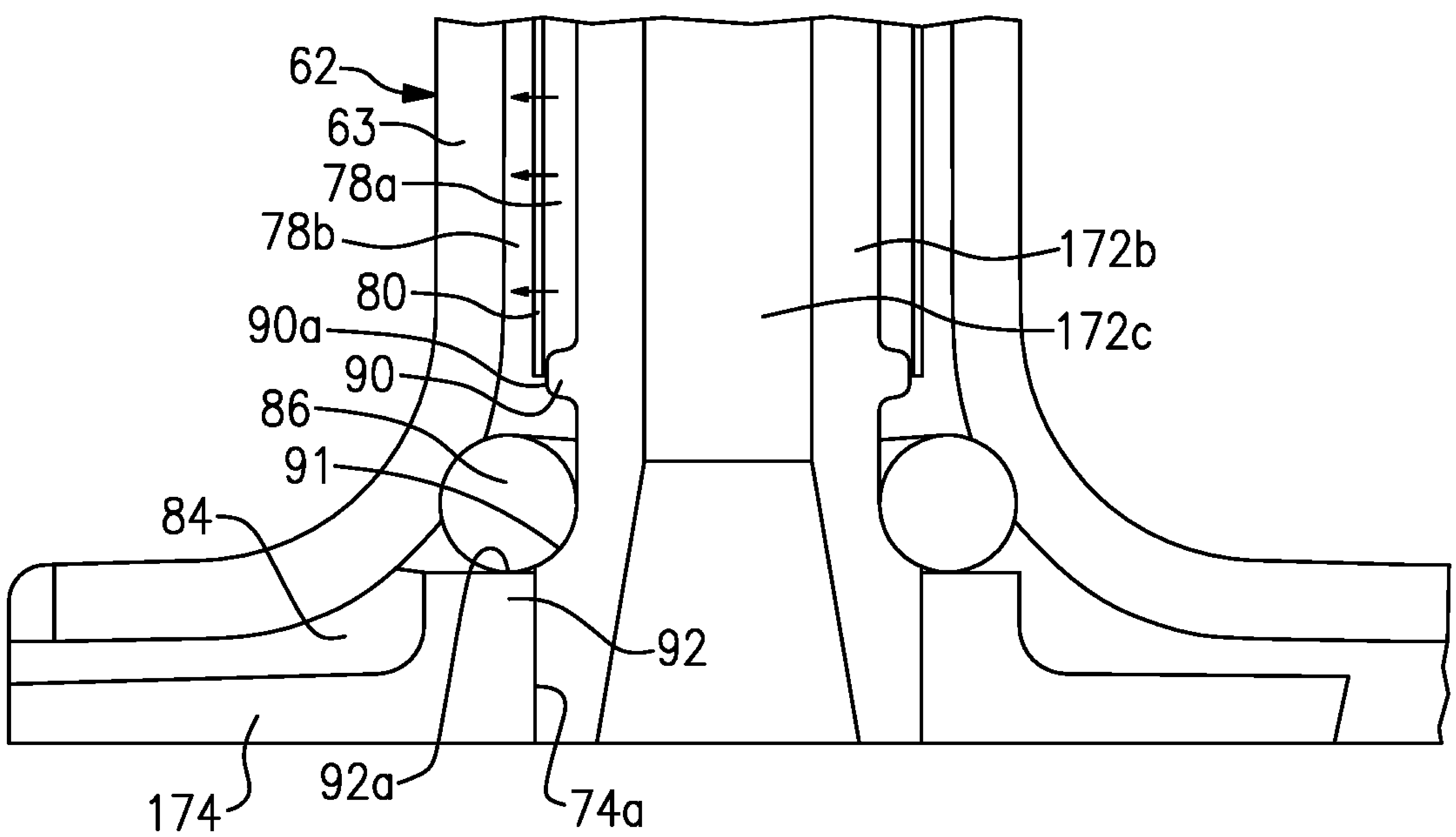

62
63
78a
78b
80
90a
90
86
91
84
172b
172c
92
92a
74a
174

FIG.3

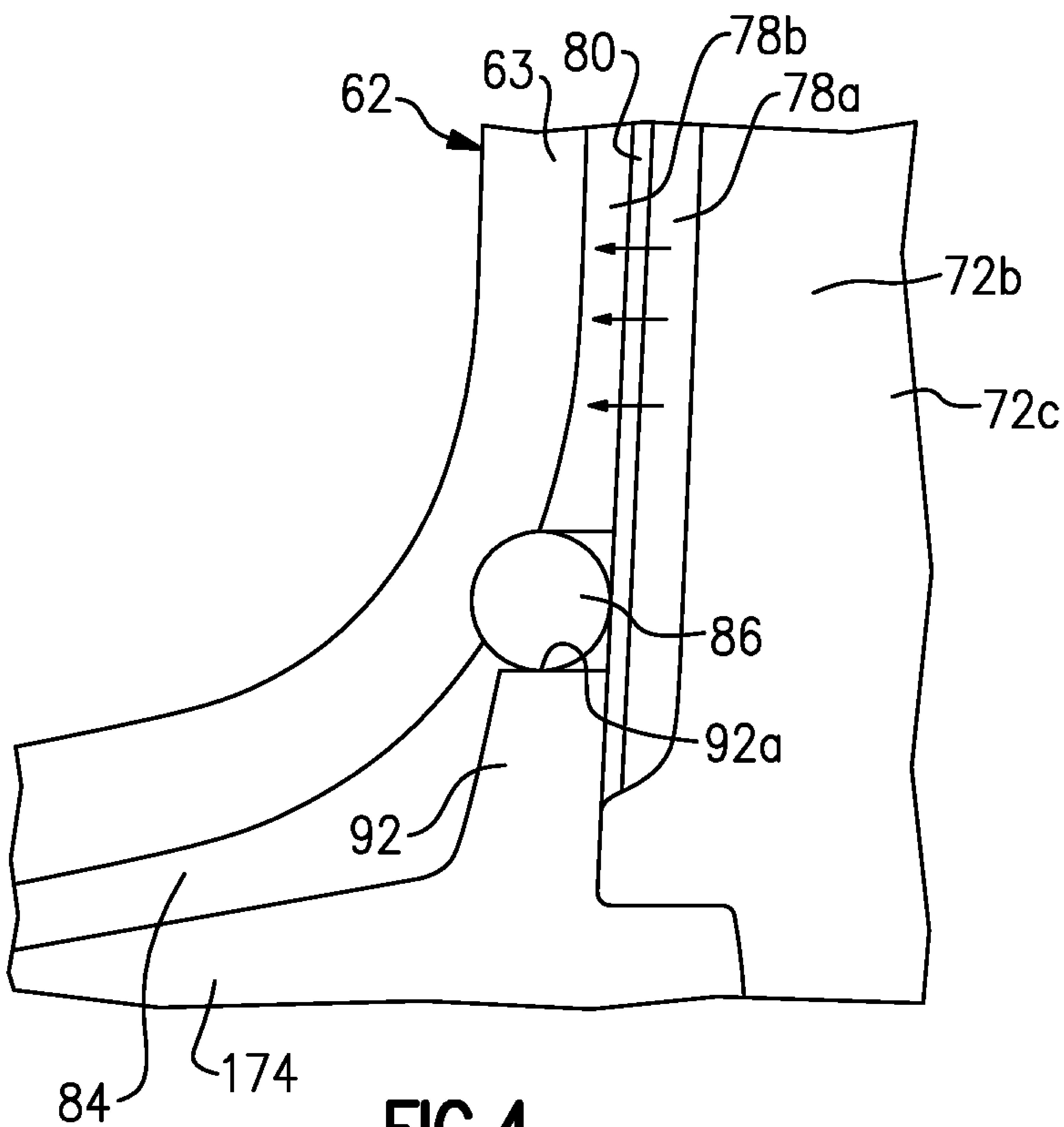

62
63
80
78b
78a
72b
72c
86
92a
92
84
174

FIG.4

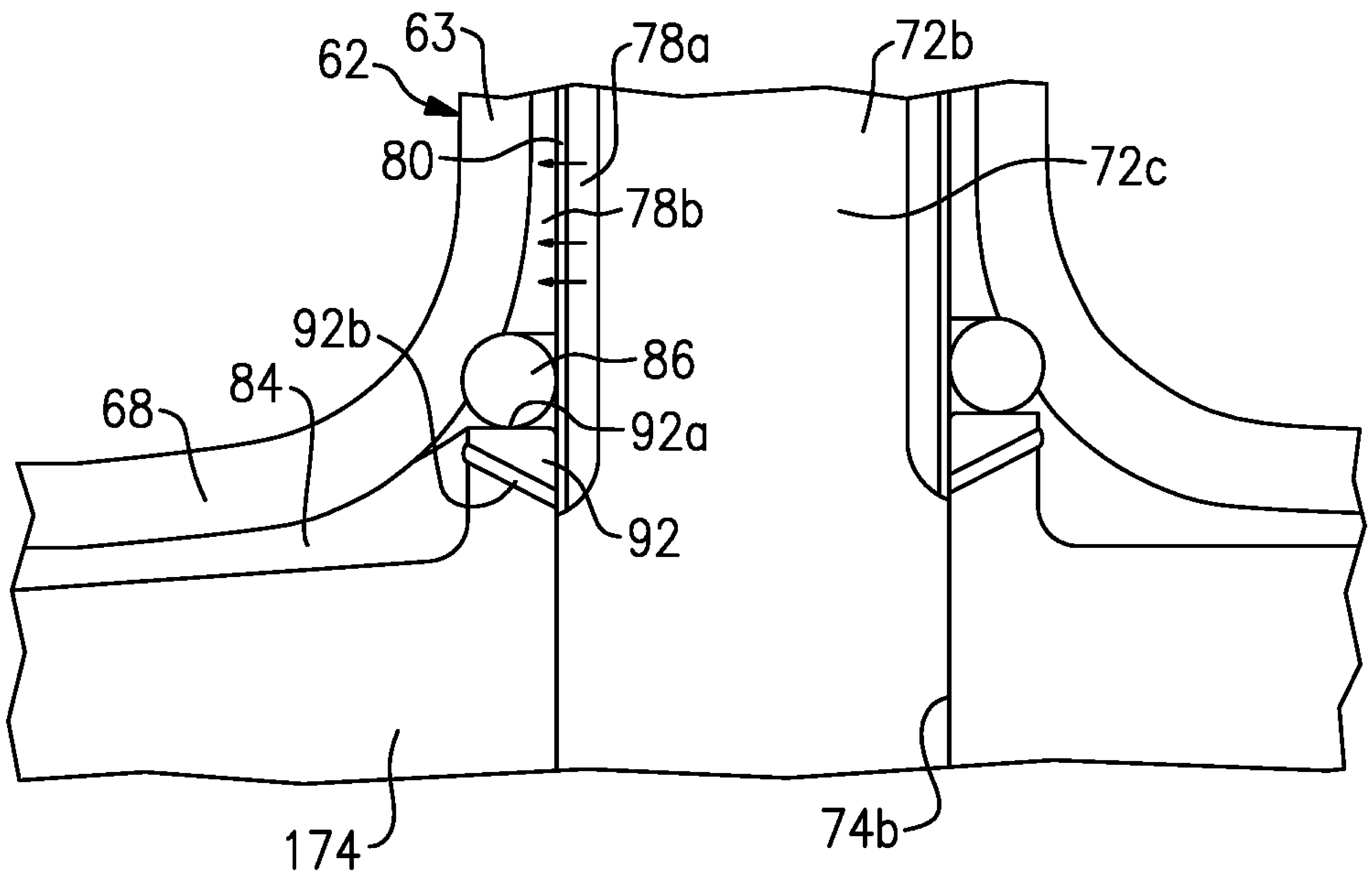

62
63
78a
72b
80
78b
72c
92b
86
68
84
92a
92
174
74b

FIG.5

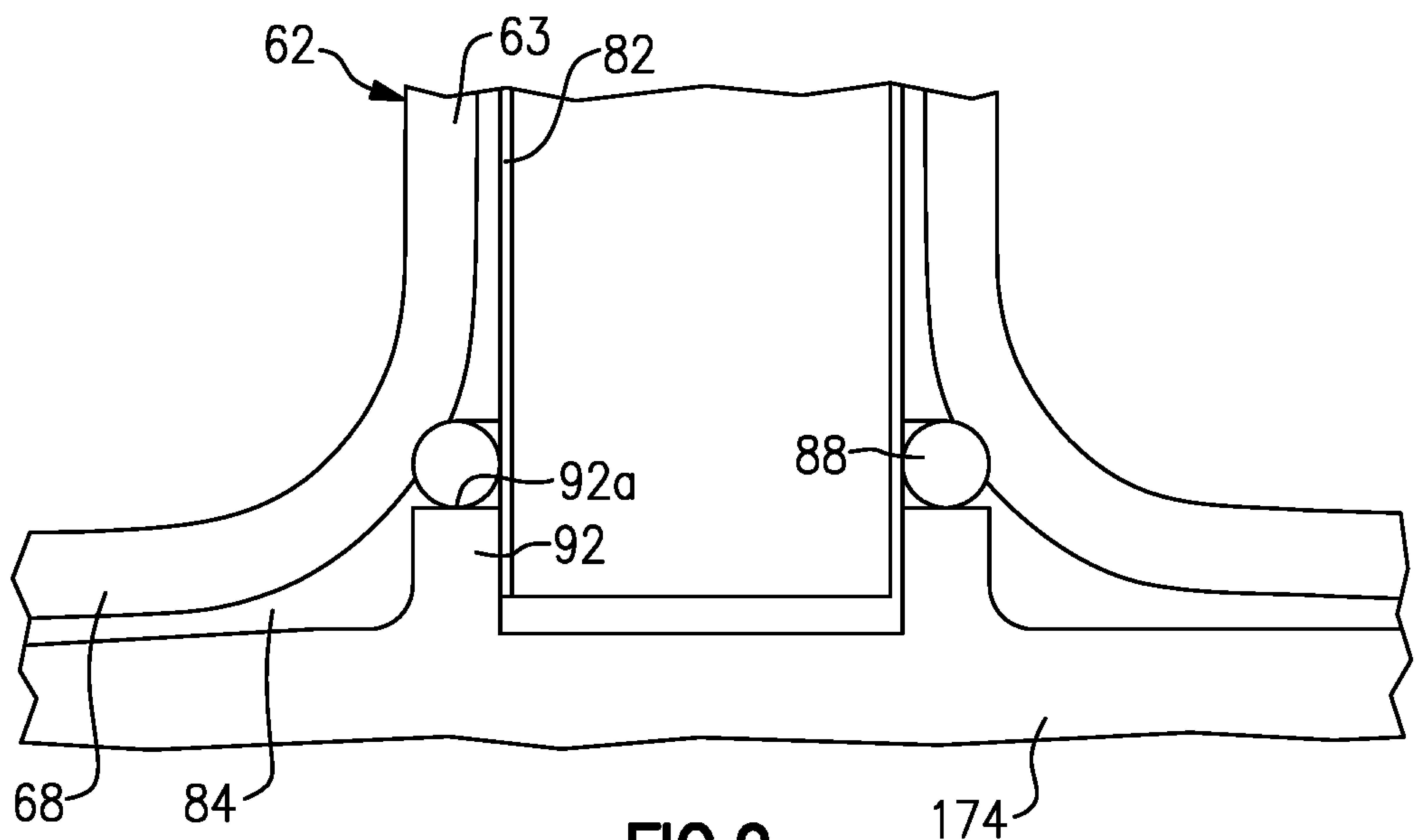

62
63
82
92a
88
92
68
84
174

FIG.9

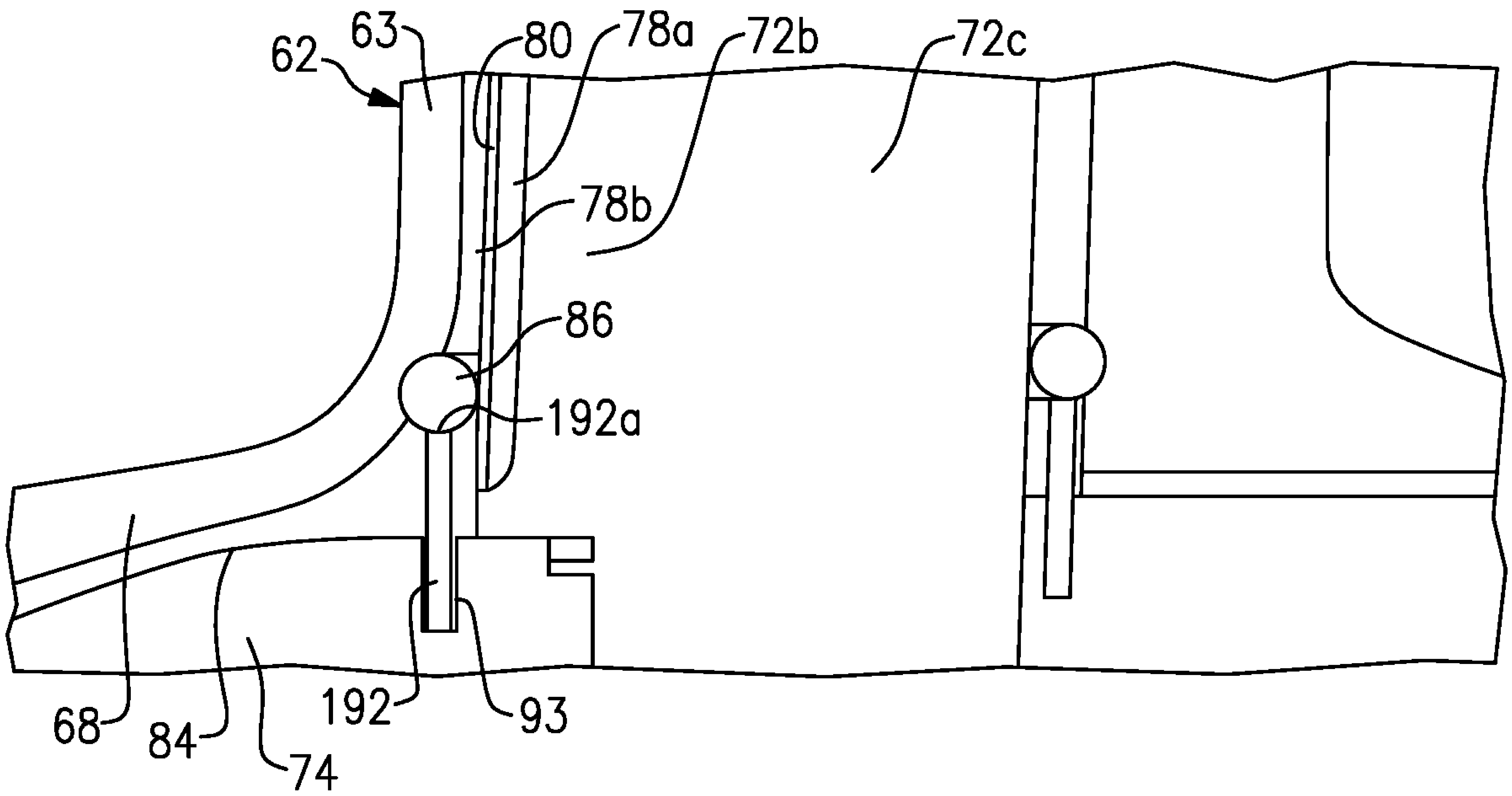

62
63
80
78a
72b
72c
78b
86
192a
68
84
74
192
93

FIG.6

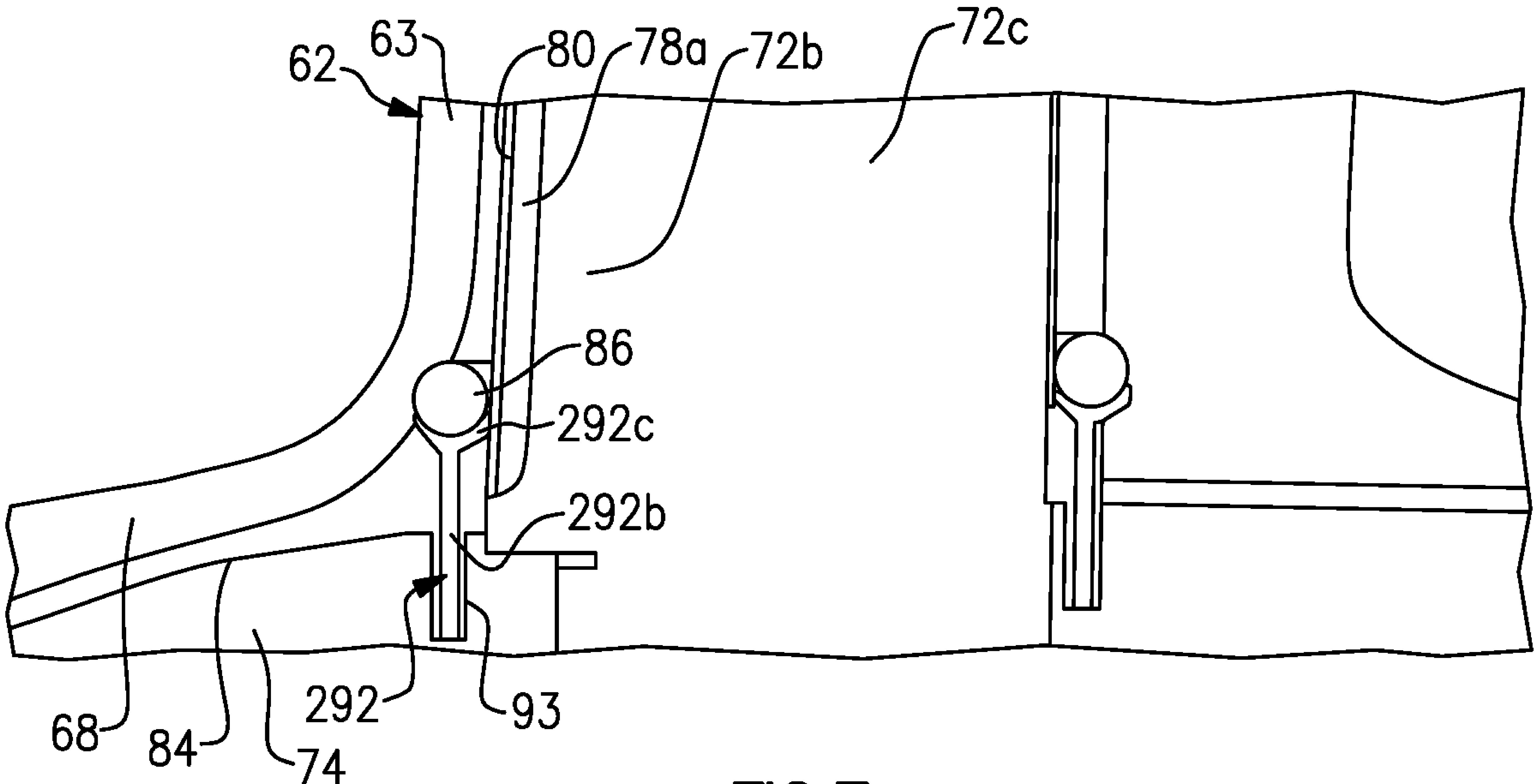

62
63
80
78a
72b
72c
86
292c
292b
68
84
74
292
93

FIG.7

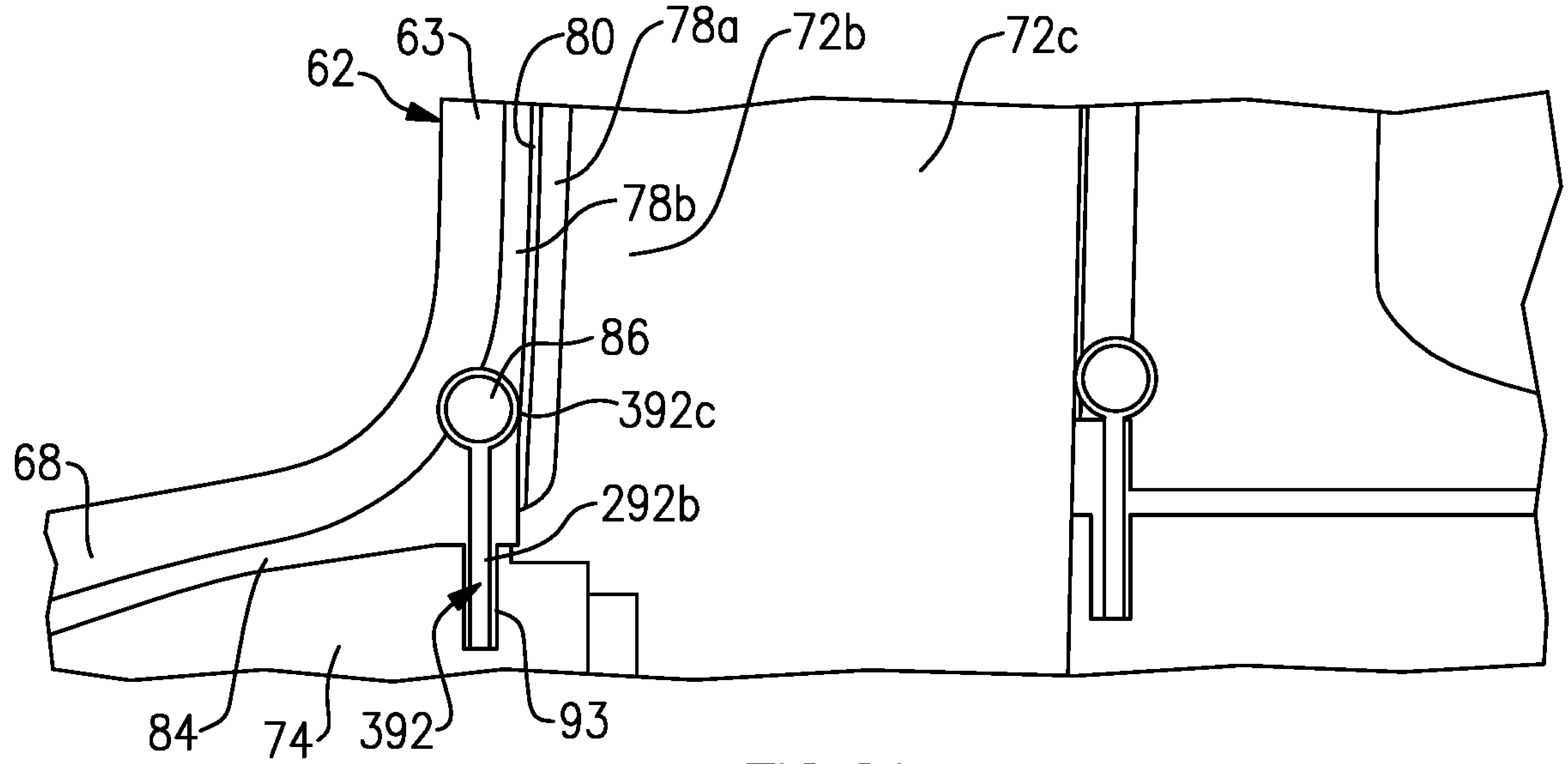

62
63
80
78a
72b
72c
78b
86
392c
68
292b
84
74
392
93

FIG.8A

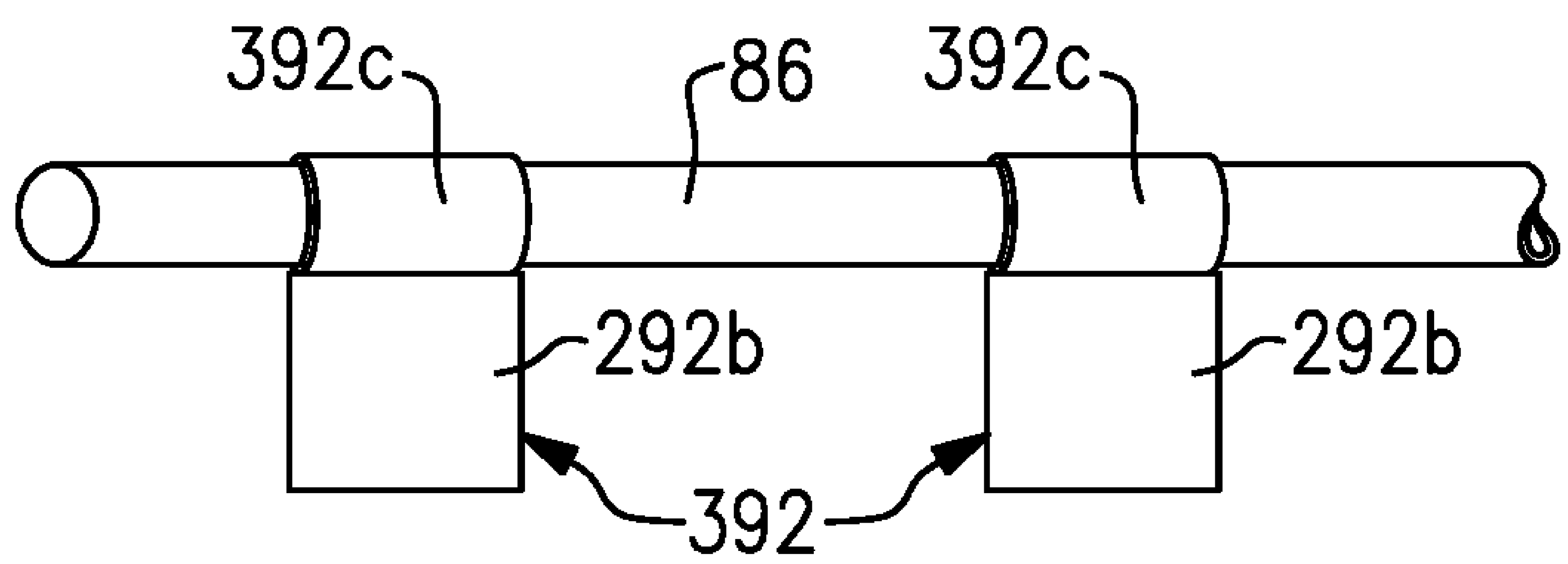

392c
86
392c
292b
292b
392

FIG.8B

VANE ARC SEGMENT WITH SEAL

BACKGROUND

A gas turbine engine typically includes a fan section, a compressor section, a combustor section and a turbine section. Air entering the compressor section is compressed and delivered into the combustion section where it is mixed with fuel and ignited to generate a high-speed exhaust gas flow. The high-speed exhaust gas flow expands through the turbine section to drive the compressor and the fan section. The compressor section may include low and high pressure compressors, and the turbine section may also include low and high pressure turbines.

Airfoils in the turbine section are typically formed of a superalloy and may include thermal barrier coatings to extend temperature capability and lifetime. Ceramic matrix composite ("CMC") materials are also being considered for airfoils. Among other attractive properties, CMCs have high temperature resistance. Despite this attribute, however, there are unique challenges to implementing CMCs in airfoils.

SUMMARY

A vane arc segment according to an example of the present disclosure includes an airfoil fairing that has an airfoil wall defining first and second fairing platforms and a hollow airfoil section extending there between. A spar has a spar leg that extends through the hollow airfoil section. The spar leg has an end portion that protrudes from the hollow airfoil section. The spar leg is spaced from the airfoil wall in the hollow airfoil section such that there is a first gap there between. A support platform is adjacent the second fairing platform such that there is a second gap there between. The support platform is secured with the end portion of the spar leg. A baffle is disposed in the first gap. The baffle is spaced apart from the airfoil wall and the spar leg so as to divide the first gap into a plenum space between the spar leg and the baffle and an impingement space between the baffle and the airfoil wall. The baffle has impingement holes directed toward the airfoil wall and connects the plenum space with the impingement space. A seal is disposed between the airfoil wall and the spar leg. The seal seals the impingement space from the second gap.

In a further embodiment of any of the foregoing embodiments, the seal is a rope seal.

In a further embodiment of any of the foregoing embodiments, the seal is radially offset from the baffle.

In a further embodiment of any of the foregoing embodiments, the spar leg includes a scallop and the seal is seated against the scallop.

In a further embodiment of any of the foregoing embodiments, the spar leg includes a protrusion that has a weld land at which the baffle is welded thereto, and the seal is radially offset from the protrusion.

In a further embodiment of any of the foregoing embodiments, the seal seats against the baffle.

In a further embodiment of any of the foregoing embodiments, the support platform includes a radially upstanding lip against which the seal seats.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip is adjacent the baffle and includes at least one through-hole connecting the plenum space and the second gap.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip includes a shank portion and a cup portion, the seal seating in the cup portion.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip includes a shank portion and a band portion, and the band portion wraps around the seal.

In a further embodiment of any of the foregoing embodiments, the hollow airfoil section includes first and second cavities, the spar leg extends through the first cavity, and there is an additional baffle disposed in the second cavity, with an additional seal disposed between the airfoil wall and the additional baffle. The additional seal seals the second cavity from the second gap.

A gas turbine engine according to an example of the present disclosure includes compressor section, a combustor in fluid communication with the compressor section, and a turbine section in fluid communication with the combustor. The turbine section has vane arc segments disposed about a central axis of the gas turbine engine. Each of the vane arc segments includes an airfoil fairing has an airfoil wall defining first and second fairing platforms and a hollow airfoil section that extends there between. A spar has a spar leg that extends through the hollow airfoil section. The spar leg has an end portion that protrudes from the hollow airfoil section. The spar leg is spaced from the airfoil wall in the hollow airfoil section such that there is a first gap there between. A support platform is adjacent the second fairing platform such that there is a second gap there between. The support platform is secured with the end portion of the spar leg. A baffle is disposed in the first gap. The baffle is spaced apart from the airfoil wall and the spar leg so as to divide the first gap into a plenum space between the spar leg and the baffle and an impingement space between the baffle and the airfoil wall. The baffle has impingement holes directed toward the airfoil wall and connect the plenum space with the impingement space. A seal is disposed between the airfoil wall and the spar leg. The seal seals the impingement space from the second gap.

In a further embodiment of any of the foregoing embodiments, the seal is a rope seal and is radially offset from the baffle.

In a further embodiment of any of the foregoing embodiments, the spar leg includes a scallop and the seal is seated against the scallop.

In a further embodiment of any of the foregoing embodiments, the spar leg includes a protrusion that has a weld land at which the baffle is welded thereto, and the seal is radially offset from the protrusion.

In a further embodiment of any of the foregoing embodiments, the seal seats against the baffle.

In a further embodiment of any of the foregoing embodiments, the support platform includes a radially upstanding lip against which the seal seats.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip is adjacent the baffle and includes at least one through-hole connecting the plenum space and the second gap.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip includes a shank portion and a cup portion, the seal seating in the cup portion.

In a further embodiment of any of the foregoing embodiments, the radially upstanding lip includes a shank portion and a band portion. The band portion wraps around the seal.

BRIEF DESCRIPTION OF THE DRAWINGS

The various features and advantages of the present disclosure will become apparent to those skilled in the art from the following detailed description. The drawings that accompany the detailed description can be briefly described as follows.

FIG. **1** illustrates a gas turbine engine.

FIG. **2** illustrates a vane arc segment from the engine.

FIG. **3** illustrates a seal between a spar leg and an airfoil fairing of the vane arc segment.

FIG. **4** illustrates another example in which the seal seats against a baffle adjacent the spar leg and is supported by a radially upstanding lip.

FIG. **5** illustrates another example in which a radially upstanding lip has one or more through-holes for cooling.

FIG. **6** illustrates another example in which there is a separable radially upstanding lip.

FIG. **7** illustrates another example in which the separable radially upstanding lip has a cup portion.

FIG. **8**A illustrates another example in which the separable radially upstanding lip has a band portion.

FIG. **8**B illustrates another example in which the band portions are at spaced intervals along the seal.

FIG. **9** illustrates a support platform that includes a radially upstanding lip.

DETAILED DESCRIPTION

FIG. **1** schematically illustrates a gas turbine engine **20**. The gas turbine engine **20** is disclosed herein as a two-spool turbofan that generally incorporates a fan section **22**, a compressor section **24**, a combustor section **26** and a turbine section **28**. The fan section **22** drives air along a bypass flow path B in a bypass duct defined within a housing **15** such as a fan case or nacelle, and also drives air along a core flow path C for compression and communication into the combustor section **26** then expansion through the turbine section **28**. Although depicted as a two-spool turbofan gas turbine engine in the disclosed non-limiting embodiment, it should be understood that the concepts described herein are not limited to use with two-spool turbofans as the teachings may be applied to other types of turbine engines including three-spool architectures.

The exemplary engine **20** generally includes a low speed spool **30** and a high speed spool **32** mounted for rotation about an engine central longitudinal axis A relative to an engine static structure **36** via several bearing systems **38**. It should be understood that various bearing systems **38** at various locations may alternatively or additionally be provided, and the location of bearing systems **38** may be varied as appropriate to the application.

The low speed spool **30** generally includes an inner shaft **40** that interconnects, a first (or low) pressure compressor **44** and a first (or low) pressure turbine **46**. The inner shaft **40** is connected to the fan **42** through a speed change mechanism, which in exemplary gas turbine engine **20** is illustrated as a geared architecture **48** to drive a fan **42** at a lower speed than the low speed spool **30**. The high speed spool **32** includes an outer shaft **50** that interconnects a second (or high) pressure compressor **52** and a second (or high) pressure turbine **54**. A combustor **56** is arranged in exemplary gas turbine **20** between the high pressure compressor **52** and the high pressure turbine **54**. A mid-turbine frame **57** of the engine static structure **36** may be arranged generally between the high pressure turbine **54** and the low pressure turbine **46**. The mid-turbine frame **57** further supports bearing systems **38** in the turbine section **28**. The inner shaft **40** and the outer shaft **50** are concentric and rotate via bearing systems **38** about the engine central longitudinal axis A which is collinear with their longitudinal axes.

The core airflow is compressed by the low pressure compressor **44** then the high pressure compressor **52**, mixed and burned with fuel in the combustor **56**, then expanded through the high pressure turbine **54** and low pressure turbine **46**. The mid-turbine frame **57** includes airfoils **59** which are in the core airflow path C. The turbines **46**, **54** rotationally drive the respective low speed spool **30** and high speed spool **32** in response to the expansion. It will be appreciated that each of the positions of the fan section **22**, compressor section **24**, combustor section **26**, turbine section **28**, and fan drive gear system **48** may be varied. For example, gear system **48** may be located aft of the low pressure compressor, or aft of the combustor section **26** or even aft of turbine section **28**, and fan **42** may be positioned forward or aft of the location of gear system **48**.

The engine **20** in one example is a high-bypass geared aircraft engine. In a further example, the engine **20** bypass ratio is greater than about six (6), with an example embodiment being greater than about ten (10), the geared architecture **48** is an epicyclic gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.3 and the low pressure turbine **46** has a pressure ratio that is greater than about five. In one disclosed embodiment, the engine **20** bypass ratio is greater than about ten (10:1), the fan diameter is significantly larger than that of the low pressure compressor **44**, and the low pressure turbine **46** has a pressure ratio that is greater than about five 5:1. Low pressure turbine **46** pressure ratio is pressure measured prior to inlet of low pressure turbine **46** as related to the pressure at the outlet of the low pressure turbine **46** prior to an exhaust nozzle. The geared architecture **48** may be an epicycle gear train, such as a planetary gear system or other gear system, with a gear reduction ratio of greater than about 2.3:1 and less than about 5:1. It should be understood, however, that the above parameters are only exemplary of one embodiment of a geared architecture engine and that the present invention is applicable to other gas turbine engines including direct drive turbofans.

A significant amount of thrust is provided by the bypass flow B due to the high bypass ratio. The fan section **22** of the engine **20** is designed for a particular flight condition—typically cruise at about 0.8 Mach and about 35,000 feet (10,668 meters). The flight condition of 0.8 Mach and 35,000 ft (10,668 meters), with the engine at its best fuel consumption—also known as "bucket cruise Thrust Specific Fuel Consumption ('TSFC)"—is the industry standard parameter of lbm of fuel being burned divided by lbf of thrust the engine produces at that minimum point. "Low fan pressure ratio" is the pressure ratio across the fan blade alone, without a Fan Exit Guide Vane ("FEGV") system. The low fan pressure ratio as disclosed herein according to one non-limiting embodiment is less than about 1.45. "Low corrected fan tip speed" is the actual fan tip speed in ft/sec divided by an industry standard temperature correction of $[(\text{Tram}\ ^\circ \text{R})/(518.7^\circ \text{R})]^{0.5}$. The "Low corrected fan tip speed" as disclosed herein according to one non-limiting embodiment is less than about 1150 ft/second (350.5 meters/second).

FIG. **2** illustrates a line representation of an example of a vane arc segment **60** from the turbine section **28** of the engine **20** (see also FIG. **1**). It is to be understood that although the examples herein are discussed in context of a vane from the turbine section, the examples can be applied to vanes in other portions of the engine **20**.

The vane arc segment **60** includes an airfoil fairing **62** that is formed by an airfoil wall **63**. The airfoil fairing **62** is comprised of a hollow airfoil section **64** and first and second platforms **66/68** between which the airfoil section **64** extends. The airfoil section **64** generally extends in a radial direction relative to the central engine axis A. Terms such as "inner" and "outer" used herein refer to location with respect to the central engine axis A, i.e., radially inner or radially outer. Moreover, the terminology "first" and "second" used herein is to differentiate that there are two architecturally distinct components or features. It is to be further understood that the terms "first" and "second" are interchangeable in that a first component or feature could alternatively be termed as the second component or feature, and vice versa.

The airfoil wall **63** is continuous in that the platforms **66/68** and airfoil section **64** constitute a unitary body. As an example, the airfoil wall **63** is formed of a ceramic matrix composite, an organic matrix composite (OMC), or a metal matrix composite (MMC) or homogeneous polymer, metallic or ceramic material. For instance, the ceramic matrix composite (CMC) is formed of ceramic fiber tows that are disposed in a ceramic matrix. The ceramic matrix composite may be, but is not limited to, a SiC/SiC ceramic matrix composite in which SiC fiber tows are disposed within a SiC matrix. Example organic matrix composites include, but are not limited to, glass fiber tows, carbon fiber tows, and/or aramid fiber tows disposed in a polymer matrix, such as epoxy. Example metal matrix composites include, but are not limited to, boron carbide fiber tows and/or alumina fiber tows disposed in a metal matrix, such as aluminum. A fiber tow is a bundle of filaments. As an example, a single tow may have several thousand filaments. The tows may be arranged in a fiber architecture, which refers to an ordered arrangement of the tows relative to one another, such as, but not limited to, a 2D woven ply or a 3D structure.

The airfoil section **64** circumscribes an interior cavity **70**, which in this example is subdivided by a rib **70***a* into first and second sub-cavities **71***a*/**71***b*. Alternatively, the airfoil section **64** may have a single cavity **70**, or the cavity **70** may be divided by additional ribs. The vane arc segment **60** further includes a spar **72** that mechanically supports the airfoil fairing **62**. The spar **72** includes a spar platform **72***a* and a spar leg **72***b* that extends from the spar platform **72***a* into the cavity **70** (through the first sub-cavity **71***a*). Although not shown, the radially outer side of the spar platform **72***a* may include attachment features that secure it to a fixed support structure, such as an engine case. The spar leg **72***b* defines an interior through-passage **72***c*.

The end of the spar leg **72***b* extends past the platform **68** so as to protrude from the fairing **62**. There is a support platform **74** adjacent the platform **68** of the airfoil fairing **62**. The support platform **74** includes a first through-hole **74***a* through which the end of the spar leg **72***b* extends. In this example, the end of the spar leg **72***b* includes a clevis mount **76**, although other mounting schemes could alternatively be used. The clevis mount **76** may include one or more prongs that protrude from the support platform **74**. The prong or prongs include a pinhole through which a pin **76***a* extends. The pin **76***a* is wider than the through-hole **74***a* of the support platform **74**. The ends of the pin **76***a* thus abut the face of the support platform **74** and thereby prevent the spar leg **72***b* from being retracted from the through-hole **74***a*. The pin **76***a* thus locks the support platform **74** to the spar leg **72***b* such that the airfoil fairing **62** is mechanically trapped between the spar platform **72***a* and the support platform **74**. It is to be appreciated that the example configuration could be used at the outer end of the airfoil fairing **62**, with the spar **72** being inverted such that the spar platform **72***a* is adjacent the (inner) platform **68** and the support platform **74** is adjacent the (outer) platform **66**. The spar **72** may be formed of a relatively high temperature resistance, high strength material, such as a single crystal metal alloy (e.g., a single crystal nickel- or cobalt-alloy).

The spar leg **72***b* is spaced from the airfoil wall **63** such that there is a first gap **78** there between. The walls of the spar leg **72***b* are solid and continuous. There is a baffle **80** disposed in the gap **78**. The baffle **80** generally circumscribes the spar leg **72***b*. The baffle **80** is spaced apart from the airfoil wall **63** and the spar leg **72***b* so as to divide the gap **78** into a plenum space **78***a* between the spar leg **72***b* and the baffle **80** and an impingement space **78***b* between the baffle **80** and the airfoil wall **63**. The baffle **80** has impingement holes (represented at unnumbered flow arrows) that are directed toward the airfoil wall **63** and connect the plenum space **78***a* and the impingement space **78***b*. The baffle **80** is formed of sheet metal but may alternatively be formed from an alloy using additive manufacturing.

The baffle **80** may not extend entirely through the airfoil section **62** to the support platform **74**. Rather, the end of the baffle **80** is joined to the spar leg **72***b* prior to the clevis mount **76**. In this regard, the impingement holes in the baffle **80** may be the exclusive exit from the plenum space **78***a* into the impingement space **78***b*.

Cooling air, such as bleed air from the compressor section **24**, is conveyed into and through the through-passage **72***c*. This cooling air is destined for a downstream cooling location, such as a tangential onboard injector (TOBI). Cooling air is also conveyed into the plenum space **78***a*. The cooling air in the plenum space **78***a* is emitted through the impingement holes in the baffle **80** onto the airfoil wall **63** for cooling thereof.

In the illustrated example, there is an additional, second baffle **82** that extends through the second sub-cavity **71***b*. The baffle **82** is also provided with cooling air and may have cooling holes therein for directing the cooling air at portions of the airfoil wall **63**. In this example, like the spar leg **72***b*, the baffle **82** protrudes from the airfoil fairing **62** and through a second through-hole **74***b* in the support platform **74**.

The support platform **74** is radially spaced from the platform **68** of the airfoil fairing **62** such that there is a second gap **84** there between. There is a first seal **86** disposed between the airfoil wall **63** and the spar leg **72***b*. The seal **86** seals the impingement space **78***b* from the second gap **84** such that cooling air in the impingement space **78***b* cannot escape into the second gap **84**. There is a second seal **88** disposed between the airfoil wall **63** and the baffle **82**. The seal **88** seals the space in the second sub-cavity **71***b* between the baffle **82** and the airfoil wall **63** from the second gap **84** such that cooling air in the second sub-cavity **71***b* cannot escape into the second gap **84**. Alternatively, if the second gap **84** is pressurized, the seals **86/88** prevent flow from the second gap **84** into the sub-cavities **71***a*/**71***b*.

In a further example, the seals **86/88** are rope seals. For example, the rope seals are formed of fibers, such as ceramic fibers, metallic fibers, graphite fibers, or polymer fibers. The fibers may be braided, knitted, or woven. Example ceramic fibers include, but are not limited to, oxide fibers. For instance, the ceramic fibers are NEXTEL fibers, which are composed of Al_2O_3, SiO_2, and B_2O_3. Example metallic fibers include, but are not limited to, nickel alloy or a cobalt alloy fibers. Example polymer fibers include, but are not limited to, meta-aramid or para-aramid fibers. For instance, the polymer fibers are NOMEX fibers, which are composed of m-phenylenediamine isophthalamide. Optionally, the rope seals may include a sheath surrounding a fiber core. The sheath can be an overbraid or foil that surrounds the core. In one example, the sheath comprises a high-temperature metallic material, such as a single crystal nickel alloy or a cobalt alloy. For instance, in the overbraid example, the sheath comprises an overbraid of metallic wire. In other examples, the sheath comprises a ceramic-based material.

FIG. **3** illustrates a further example in which the support platform **174** and spar leg **172***b* are configured to facilitate positioning of the seal **86**. In this disclosure, like reference numerals designate like elements where appropriate and reference numerals with the addition of one-hundred or multiples thereof designate modified elements that are understood to incorporate the same features and benefits of the corresponding elements. Here, the spar leg **172***b* includes a protrusion **90** that extends around the periphery of the spar leg **172***b*. The protrusion has a weld land **90***a* at which the end of the baffle **80** is welded to. The spar leg **172***b* further includes a scallop **91** that is radially offset from the protrusion **90**. The scallop **91** is a sloped portion of the spar leg **172***b* that curves outwards. The curvature of the scallop **91** provides a seat against which the seal **86** is positioned (the seal **86** is thus radially offset from the protrusion **90**). The curvature cradles the seal **86** and thereby serves to keep the seal **86** from shifting radially inwards (toward the support platform **174**). The protrusion **90** serves to keep the seal from shifting radially outwards.

The support platform **174** in the illustrated example also includes a radially upstanding lip **92**. The lip **92** extends around the periphery of the first through-hole **74***a* of the support platform **174**. The lip **92** includes a radially-facing surface **92***a* against which the seal **86** seats. The lip **92** further prevents the seal **86** from shifting radially (inwards in this example).

In the example of FIG. **3**, the seal **86** seals against the airfoil wall **63** and the spar leg **172***b*. FIG. **4** illustrates a modified configuration in which the baffle **80** extends radially farther (inwards) such that the seal **86** seals against the airfoil wall **63** and the surface of the baffle **80**.

FIG. **5** illustrates a further example that is the same as the example of FIG. **4** except that the lip **92** includes one or more through-holes **92***b* that connect the plenum space **78***a* and the second gap **84**. Cooling air from the plenum space **78***a* is emitted through the cooling hole(s) **92***b* toward the fillet, platform **68**, and/or airfoil section **64** of the fairing **62**. As shown, the cooling hole(s) **92***b* may be sloped (relative to the engine axis A) such that the cooling air impinges on the fillet region or other regions which are susceptible to extreme temperatures.

In the example of FIG. **4**, the radially upstanding lip **92** is integral with the support platform **174**. FIG. **6** illustrates an additional example in which the support platform **74** has a separable radially upstanding lip **192**. For instance, the lip **192** is a separate piece from the body of the support platform **74**. In this regard, the support platform **74** includes a slot **93** into which a portion of the lip **192** is received. the slot **93** facilitates retaining and positioning the lip **192**. Like the lip **92**, the lip **192** includes a radially-facing surface **192***a* against which the seal **86** seats to prevent the seal **86** from shifting radially (inwards in this example).

The example in FIG. **7** is the same as in FIG. **6** except that here the separable radially upstanding lip **292** has a shank portion **292***b* and a cup portion **292***c*. The shank portion **292***b* is received into the slot **93**. The cup portion **292***c* is located at the radial end of the shank portion **292***b*. The cup portion **292***c* is curved and the seal **86** is seated against the curved surface of the cup portion **292***c* to retain and position the seal **86** in place.

The example in FIG. **8**A is the similar to the example of FIG. **7** except that here instead of a cup portion the separable radially upstanding lip **392** has a band portion **392***c*. The shank portion **292***b* is received into the slot **93**. The band portion **392***c* is located at the radial end of the shank portion **292***b*. The band portion **392***c* wraps around the seal **86** to retain and position the seal **86** in place. The band portion **392***c* may initially be "open" so as to enable the seal **86** to be received therein, and then subsequently bent to wrap around the seal **86**.

The shank portion **292***b* and band portion **392***c* may be coextensive with the seal **86** or provided at intervals along the seal **86**. For example, as shown in FIG. **8**B, the shank portion **292***b* and band portion **392***c* are provided at spaced intervals along the seal **86**. The portion of the seal **86** between the band portions **392***c* is not directly supported by the shank portion **292***b* and the band portion **392***c*, however, the intervals may be relatively close together to facilitate the elimination of sagging of the seal **86** there between.

As mentioned above, the seal **88** seals the space in the second sub-cavity **71***b* between the baffle **82** and the airfoil wall **63** from the second gap **84** such that cooling air in the second sub-cavity **71***b* cannot escape into the second gap **84**. As shown in FIG. **9**, the support platform **174** may include an additional radially upstanding lip **92** around the periphery of the second through-hole **74***b* of the support platform **174** to support the seal **88**. Additionally, similar to the spar leg **72***b*, the baffle **82** may have a scallop to further facilitate positioning.

As indicated, the seals **86**/**88** facilitate sealing from the second gap **84**. In particular, sealing against composite materials that form the airfoil fairing **62** is challenging because such composites may have higher surface roughness in comparison to traditional metallic alloy surfaces that are machined. Rope seals, which are flexible and conform to surface contours, facilitate sealing against such surfaces but must be maintained in proper position. In this regard, the seals **86**/**88** are trapped between the airfoil fairing **62**, the support platform **74**/**174** and the respective spar leg **72***b* or baffle **82**. One or more spring members may be provided between the platform **66** of the airfoil fairing **62** and the spar platform **72***a* to bias the airfoil fairing towards the support platform **74**/**174**. Such a biasing facilitates providing a constant clamping force of the airfoil fairing **62** against the seals **86**/**88** to thereby further maintain position of the seals **86**/**88**.

Although a combination of features is shown in the illustrated examples, not all of them need to be combined to realize the benefits of various embodiments of this disclosure. In other words, a system designed according to an embodiment of this disclosure will not necessarily include all of the features shown in any one of the Figures or all of the portions schematically shown in the Figures. Moreover, selected features of one example embodiment may be combined with selected features of other example embodiments.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed examples may become apparent to those skilled in the art that do not necessarily depart from this disclosure. The scope of legal protection given to this disclosure can only be determined by studying the following claims.

What is claimed is:

1. A vane arc segment comprising:

an airfoil fairing having an airfoil wall defining first and second fairing platforms and a hollow airfoil section extending there between;

a spar having a spar leg that extends through the hollow airfoil section, the spar leg having an end portion that protrudes from the hollow airfoil section, the spar leg being spaced from the airfoil wall in the hollow airfoil section such that there is a first gap there between;

a support platform adjacent the second fairing platform such that there is a second gap there between, the support platform being secured with the end portion of the spar leg;

a baffle disposed in the first gap, the baffle being spaced apart from the airfoil wall and the spar leg so as to divide the first gap into a plenum space between the spar leg and the baffle and an impingement space between the baffle and the airfoil wall, the baffle having impingement holes directed toward the airfoil wall and connecting the plenum space with the impingement space; and

a seal disposed between the airfoil wall and the spar leg, the seal sealing the impingement space from the second gap.

2. The vane arc segment as recited in claim **1**, wherein the seal is a rope seal.

3. The vane arc segment as recited in claim **1**, wherein the seal is radially offset from the baffle.

4. The vane arc segment as recited in claim **1**, wherein the spar leg includes a scallop and the seal is seated against the scallop.

5. The vane arc segment as recited in claim **1**, wherein the spar leg includes a protrusion that has a weld land at which the baffle is welded thereto, and the seal is radially offset from the protrusion.

6. The vane arc segment as recited in claim **1**, wherein the seal seats against the baffle.

7. The vane arc segment as recited in claim **1**, wherein the support platform includes a radially upstanding lip against which the seal seats.

8. The vane arc segment as recited in claim **7**, wherein the radially upstanding lip is adjacent the baffle and includes at least one through-hole connecting the plenum space and the second gap.

9. The vane arc segment as recited in claim **7**, wherein the radially upstanding lip includes a shank portion and a cup portion, the seal seating in the cup portion.

10. The vane arc segment as recited in claim **7**, wherein the radially upstanding lip includes a shank portion and a band portion, the band portion wrapping around the seal.

11. The vane arc segment as recited in claim **1**, wherein the hollow airfoil section includes first and second cavities, the spar leg extends through the first cavity, and there is an additional baffle disposed in the second cavity, with an additional seal disposed between the airfoil wall and the additional baffle, the additional seal sealing the second cavity from the second gap.

12. A gas turbine engine comprising:

a compressor section;

a combustor in fluid communication with the compressor section; and

a turbine section in fluid communication with the combustor, the turbine section having vane arc segments disposed about a central axis of the gas turbine engine, each of the vane arc segments includes:

an airfoil fairing having an airfoil wall defining first and second fairing platforms and a hollow airfoil section extending there between,

a spar having a spar leg that extends through the hollow airfoil section, the spar leg having an end portion that protrudes from the hollow airfoil section, the spar leg being spaced from the airfoil wall in the hollow airfoil section such that there is a first gap there between,

a support platform adjacent the second fairing platform such that there is a second gap there between, the support platform being secured with the end portion of the spar leg,

a baffle disposed in the first gap, the baffle being spaced apart from the airfoil wall and the spar leg so as to divide the first gap into a plenum space between the spar leg and the baffle and an impingement space between the baffle and the airfoil wall, the baffle having impingement holes directed toward the airfoil wall and connecting the plenum space with the impingement space, and

a seal disposed between the airfoil wall and the spar leg, the seal sealing the impingement space from the second gap.

13. The gas turbine engine as recited in claim **12**, wherein the seal is a rope seal and is radially offset from the baffle.

14. The gas turbine engine as recited in claim **12**, wherein the spar leg includes a scallop and the seal is seated against the scallop.

15. The gas turbine engine as recited in claim **12**, wherein the spar leg includes a protrusion that has a weld land at which the baffle is welded thereto, and the seal is radially offset from the protrusion.

16. The gas turbine engine as recited in claim **12**, wherein the seal seats against the baffle.

17. The gas turbine engine as recited in claim **12**, wherein the support platform includes a radially upstanding lip against which the seal seats.

18. The gas turbine engine as recited in claim **17**, wherein the radially upstanding lip is adjacent the baffle and includes at least one through-hole connecting the plenum space and the second gap.

19. The gas turbine engine as recited in claim **17**, wherein the radially upstanding lip includes a shank portion and a cup portion, the seal seating in the cup portion.

20. The gas turbine engine as recited in claim **17**, wherein the radially upstanding lip includes a shank portion and a band portion, the band portion wrapping around the seal.

* * * * *